

WHAT IS CLAIMED IS:

1. A measurement apparatus for measuring color of an object, comprising:

a main body having an opening opposed to an object to be measured;

a plurality of illuminators for illuminating a surface of the object in directions different from one another;

a light detector for detecting reflected light in a specified direction from the object illuminated by the plurality of illuminators and outputting light detection signals corresponding to light intensities;

a first calculator for calculating reflection characteristic measurement values of the measurement object in correspondence with the plurality of illuminators based on the light detection signals;

a storage device for storing an approximate function having an angle of an illuminating direction with respect to a reference direction as a variable if the reference direction is a direction symmetrical with the specific direction with respect to a center axis of the main body in parallel to a normal to the opening, and having a plurality of undetermined coefficients including an angle of inclination of the center axis of the main body with respect to a normal to the surface of the object; and

a second calculator for determining a plurality of undetermined coefficients based on the respective reflection

characteristic measurement values and the angles of the illuminating directions, and correcting the respective reflection characteristic measurement values using the approximate function whose undetermined coefficients are determined.

2. A measurement apparatus according to claim 1, wherein the approximate function is a symmetrical function having a maximum value at a specified angle deviated from the reference direction by the angle of inclination of the center axis of the main body with respect to the normal to the object surface.

3. A measurement apparatus according to claim 2, wherein the approximate function is a Gaussian function.

4. A measurement apparatus according to claim 2, wherein the approximate function has a specified number of undetermined coefficients, and the plurality of illuminators include at least the specified number of illuminators.

5. A measurement apparatus according to claim 2, wherein the plurality of illuminators include a first illuminator provided at one side of the reference direction where the center axis of the main body is located and a second illuminator provided on the other side of the reference direction.

6. A measurement apparatus according to claim 5, wherein the first and second illuminators are provided in positions symmetrical with each other with respect to the reference direction.

7. A measurement apparatus according to claim 1, wherein each of the plurality of illuminators includes

a light source;

a beam restricting plate having an opening through which a beam from the light source passes;

a collimator lens for converging the beam having passed through the opening, the opening being located in vicinity of a focusing position of the collimator lens and having a rectangular shape whose sides parallel to a measurement plane including an optical axis of the light detector and optical axes of the plurality of illuminators are shorter and whose sides perpendicular to the measurement plane are longer.

8. A measurement apparatus according to claim 1, wherein each of the plurality of illuminators includes

a light source;

a beam restricting plate having a first and second openings through which a beam from the light source passes;

a collimator lens for converging the beam having passed through the first and second openings, the first and second openings being located in vicinity of a focusing position of the collimator lens in positions symmetrical with each other with respect to a measurement plane including an optical axis of the light detector and optical axes of the plurality of illuminators.

9. A measurement apparatus according to claim 1, wherein the reflection characteristic is a spectral reflection characteristic dependent on wavelength.

10. A measurement apparatus for measuring color of an object, comprising:

a main body having an opening opposed to an object to be measured;

a plurality of illuminators for illuminating a surface of the object in directions different from one another, the plurality of illuminators including:

a first illuminator provided at one side of a reference direction where a center axis of the main body is located, and

a second illuminator provided on the other side of the reference direction,

if the reference direction is a direction symmetrical with the specific direction with respect to the center axis of the main body in parallel to a normal to the opening,

the first and second illuminators being provided in positions symmetrical with each other with respect to the reference direction;

a light detector for detecting reflected light in a specified direction from the object illuminated by the plurality of illuminators and outputting light detection signals corresponding to light intensities; and

a calculator for calculating a reflection characteristic of the object corresponding to the first illuminator based on a sum of the light detection signals corresponding to the first and second illuminator.

11. A measurement apparatus according to claim 10, wherein the first and second illuminators simultaneously illuminate the object.

12. A measurement apparatus according to claim 11, wherein the first and second illuminator are provided with a common light source shared thereby.

13. A measurement apparatus according to claim 10,
wherein each of the plurality of illuminators includes

a light source;

a beam restricting plate having an opening through which a
beam from the light source passes;

a collimator lens for converging the beam having passed
through the opening, the opening being located in vicinity of a
focusing position of the collimator lens and having a
rectangular shape whose sides parallel to a measurement plane
including an optical axis of the light detector and optical axes
of the plurality of illuminators are shorter and whose sides
perpendicular to the measurement plane are longer.

14. A measurement apparatus according to claim 10,
wherein each of the plurality of illuminators includes

a light source;

a beam restricting plate having a first and second openings
through which a beam from the light source passes;

a collimator lens for converging the beam having passed
through the first and second openings, the first and second
openings being located in vicinity of a focusing position of the
collimator lens in positions symmetrical with each other with
respect to a measurement plane including an optical axis of the
light detector and optical axes of the plurality of
illuminators.

15. A measurement apparatus according to claim 10, wherein the reflection characteristic is a spectral reflection characteristic dependent on wavelength.

16. A measurement apparatus for measuring color of an object, comprising:

a main body having an opening opposed to an object to be measured;

an illuminator for illuminating a surface of the object in a specific direction;

a plurality of light detectors for detecting reflected light in directions different from one another from the object illuminated by the illuminator and outputting light detection signals corresponding to light intensities;

a first calculator for calculating reflection characteristic measurement values of the object in correspondence with the plurality of light detectors based on the light detection signals;

a storage device for storing an approximate function having an angle of a light detecting direction with respect to a reference direction as a variable if the reference direction is a direction symmetrical with the specific direction with respect to a center axis of the main body in parallel to a normal to the measurement opening, and having a plurality of undetermined

coefficients including an angle of inclination of the center axis of the main body with respect to a normal to the surface of the object; and

a second calculator for determining a plurality of undetermined coefficients based on the respective reflection characteristic measurement values and the angles of the light detecting directions, and correcting the respective reflection characteristic measurement values using the approximate function whose undetermined coefficients are determined.

17. A measurement apparatus according to claim 16, wherein the approximate function is a symmetrical function having a maximum value at a specified angle deviated from the reference direction by the angle of inclination of the center axis of the main body with respect to the normal to the object surface.

18. A measurement apparatus according to claim 17, wherein the approximate function is a Gaussian function.

19. A measurement apparatus according to claim 17, wherein the approximate function has a specified number of undetermined coefficients, and the plurality of light detectors include at least the specified number of light detectors.

20. A measurement apparatus according to claim 17, wherein the plurality of light detectors include a first light detector provided at one side of the reference direction where the center axis of the main body is located and a second light detector provided on the other side of the reference direction.

21. A measurement apparatus according to claim 20, wherein the first and second light detectors are provided in positions symmetrical with each other with respect to the reference direction.

22. A measurement apparatus according to claim 16, wherein the illuminator includes:

a light source;

a beam restricting plate having an opening through which a beam from the light source passes;

a collimator lens for converging the beam having passed through the opening, the opening being located in vicinity of a focusing position of the collimator lens and having a rectangular shape whose sides parallel to a measurement plane including optical axes of the plurality of light detectors and an optical axis of the illuminator are shorter and whose sides perpendicular to the measurement plane are longer.

23. A measurement apparatus according to claim 16,
wherein the illuminator includes:

a light source;

a beam restricting plate having a first and second openings
through which a beam from the light source passes;

a collimator lens for converging the beam having passed
through the first and second openings, the first and second
openings being located in vicinity of a focusing position of the
collimator lens in positions symmetrical with each other with
respect to a measurement plane including optical axes of the
plurality of light detectors and an optical axis of the
illuminator.

~~24. A measurement apparatus according to claim 16,~~
wherein the reflection characteristic is a spectral reflection
characteristic dependent on wavelength.

25. A measurement apparatus for measuring color of an
object, comprising:

a main body having an opening opposed to an object to be
measured;

an illuminator for illuminating a surface of the object in
a specific direction;

a plurality of light detectors for detecting reflected
light in directions different from one another from the object

illuminated by the illuminator and outputting light detection signals corresponding to light intensities, the plurality of light detectors including:

a first light detector provided at one side of a reference direction where a center axis of the main body is located, and

a second light detector provided on the other side of the reference direction,

if the reference direction is a direction symmetrical with the specific direction with respect to the center axis of the main body in parallel to a normal to the opening,

the first and second light detectors being provided in positions symmetrical with each other with respect to the reference direction;

a calculator for calculating a reflection characteristic of the object corresponding to the first light detector based on a sum of the light detection signals corresponding to the first and second light detectors.

26. A measurement apparatus according to claim 25, wherein the illuminator includes:

a light source;

a beam restricting plate having an opening through which a beam from the light source passes;

a collimator lens for converging the beam having passed through the opening, the opening being located in vicinity of a focusing position of the collimator lens and having a rectangular shape whose sides parallel to a measurement plane including optical axes of the plurality of light detectors and an optical axis of the illuminator are shorter and whose sides perpendicular to the measurement plane are longer.

27. A measurement apparatus according to claim 25, wherein the illuminator includes:

a light source;

a beam restricting plate having a first and second openings through which a beam from the light source passes;

a collimator lens for converging the beam having passed
through the first and second openings, the first and second openings being located in vicinity of a focusing position of the collimator lens in positions symmetrical with each other with respect to a measurement plane including optical axes of the plurality of light detectors and an optical axis of the illuminator.

28. A measurement apparatus according to claim 25, wherein the reflection characteristic is a spectral reflection characteristic dependent on wavelength.